A GROUND-TRAPPING SURVEY FOR SMALL MAMMALS IN CONTINUOUS FOREST AND TWO ISOLATED TROPICAL RAINFOREST RESERVES

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Laurance, S. G. W. & Laurance, W. F. 1995 12 01: A ground-trapping survey for small mammals in continuous forest and two isolated tropical rainforest reserves. *Memoirs of the Queensland Museum* **38**(2): 597-602. Brisbane. ISSN 0079-8835.

We used mark-recapture methods to compare small mammal assemblages between continuous rainforest and two small (c. 500 ha), isolated rainforest reserves in north Queensland, Lake Eacham and Lake Barrine National Parks. Both parks had abundant populations of native rodents. *Uromys caudimaculatus* and *Melomys cervinipes* were significantly more abundant in the parks than continuous forest, while *Rattus fuscipes* was significantly less abundant in the parks. A few non-rainforest rodents (*Mus musculus* and *R. lutreolus*) and the edge-favouring *Antechinus flavipes* were captured in the remnants, but not in continuous forest. *Hypsiprimnodon moschatus* was present in both parks and continuous forest, while several other rare, forest-dependent mammals (e.g. *Antechinus godmani, A. stuartii, Dasyurus maculatus*) were not detected. Several of these trends have been observed in other rainforest remnants in the region, suggesting small mammal assemblages in these isolated parks have been influenced by forest fragmentation. ☐ *rainforest mammals, trapping, forest fragmentation.*

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Forest fragmentation can cause a wide range of ecological effects, including biotic and microclimatic changes associated with abrupt forest edges (Andren & Angelstam, 1988; Kapos, 1989; Williams-Linera, 1990; Laurance, 1991b), the decline or loss of specialised, forest-dependent fauna (Lovejoy et al., 1986; Laurance, 1991a), and dramatic changes in abundances of some species (Terborgh, 1992). Genetic changes, such as a progressive erosion of allelic diversity and heterozygosity, also may affect fragmented populations (Leung et al., 1993).

Large-scale clearing and fragmentation of tropical rainforest on the Atherton and Evelyn Tablelands in north Queensland began in the early 1900's and proceeded rapidly for the next several decades. By 1980, over 76,000ha of forest had been removed (Winter et al., 1987), leaving only scattered forest fragments on flatter areas of the Tablelands, ranging from about 1 to 600ha in area (Laurance, 1991a).

Two of the largest forest remnants on the Tablelands are Lake Eacham and Lake Barrine National Parks. The parks were initially designated as Scenic Reserves in 1888, then gazetted as National Parks in 1934 (Matthews, 1993). Each park is about 500ha in area with relic volcanic lakes occupying 103ha at Barrine and 52ha at Eacham. An Eacham Parish map published in 1931 identifies property subdivisions completely surrounding both parks, suggesting they have been isolated from primary forest for at least 64 years.

The mammal faunas of the two parks have received only limited attention. Non-systematic trapping was conducted in both parks in the 1930's and the 1970's, mainly for mammal taxonomic studies (Taylor & Horner, 1973). J. W. Winter (pers. comm.) conducted spotlighting and trapping surveys at Lake Eacham in the mid-1970's, but Lake Barrine has not been surveyed systematically, nor have the mammal faunas in the parks been contrasted with those in nearby continuous forest.

The aim of this study was to contrast small mammal assemblages at Lakes Eacham and Barrine National Parks with those found in nearby continuous rainforest. These findings are relevant to the development of park management strategies, such as the creation of faunal corridors, which are currently being implemented to help ameliorate the effects of forest fragmentation.

METHODS

Lakes Eacham and Barrine (740-800m elevation) are located near the NE margin of the Atherton Tableland. The parks are separated from Gadgarra State Forest (680-900m elevation) by a clearing 1.5-2.5km in width comprised by cattle pastures and second-growth forest (Fig. 1). At

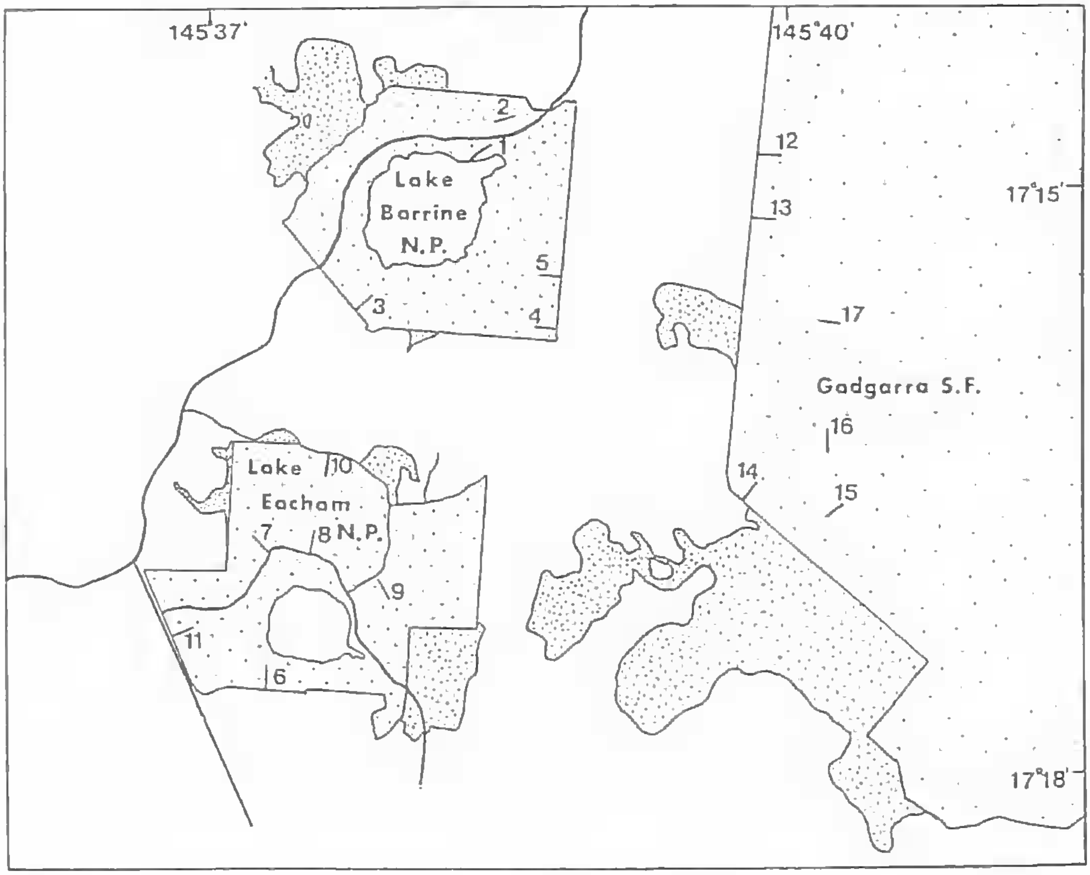

FIG. 1. Map of study area on the Atherton Tableland in north Queensland, showing locations of 17 trapping transects. Lightly stippled areas are rainforest, darkly stippled areas are second-growth forest, and unstippled areas are mostly cattle pastures.

Gadgarra, upland (>600m elevation) forests occur in a relatively narrow (4-6km-wide) band but are contiguous with the extensive Atherton Uplands (100,000ha). Much of Gadgarra was selectively logged in the 1950's and 1960's (Queensland Forest Service records). Forests at all three sites are mostly complex mesophyll vine-forest on basaltic soils, with patches of simple notophyll vine-forest on poorer metamorphic soils (Tracey, 1982).

Eacham and Barrine were censused in late July and early August 1994, while Gadgarra was censused in early October. Traps were positioned along a series of 210m-long transects. Each transect had 8 cage traps (30 x 30 x 60cm) and 14 Elliot box-traps (10 x 11 x 30cm) spaced in a regular sequence at 10 m intervals. Elliots traps were baited with a mixture of rolled oats and vanilla essence, while cages were baited alternatively with the oats-vanilla mixture or dog food (Chicken Chupp). Traps were operated for 4 consecutive nights.

Eacham and Gadgarra were each sampled with 6 transects (528 trap-nights each), while Barrine had 5 transects (440 trap-nights). At each site, 2-3 transects were used to sample forest interiors, while the remaining transects began at the forest edge and proceeded toward the interior (Fig. 1). Captured mammals were ear-tagged, weighed and examined to assess sex and reproductive condition, then released.

RESULTS

ABUNDANT RODENTS

We recorded 603 mammal captures (400 individuals) during the study. Four native rodents, the fawn-footed melomys *Melomys cervinipes*, Cape York rat *Rattus leucopus*, bush rat *R. fuscipes*, and white-tailed rat *Uromys caudimaculatus*, were numerically dominant, comprising 94-98% of individuals captured at each site. The relative proportions of the four species did not differ significantly between the two forest fragments (χ^2=6.63, p>0.05), while proportions in each fragment differed strongly from those in continuous forest (Eacham vs Gadgarra: χ^2=44.41, p<0.001; Barrine vs Gadgarra: χ^2=37.18, p<0.001; Chi-square tests for independence, $d.f.$=3 in all cases). Because rodent communities in the two fragments appeared similar in composition, we pooled data from the fragment sites for the subsequent analysis.

We compared the mean abundance of each species in the two fragments to those in continuous forest (Fig. 2). *Melomys* (p=0.019) and *Uromys* (p=0.012) were both significantly more abundant in the fragments, while *Rattus fuscipes* was significantly less abundant (p=0.001). *Rattus leucopus* was quite abundant at Barrine but was patchily distributed and did not differ significantly between fragmented and continuous forest (p=0.684). Total rodent abundance (i.e. the combined abundances of the four common species) did not differ significantly between fragmented and continuous forest (p=0.546; all Mann-Whitney U-tests), although rodent populations in the fragments exceeded those in continuous forest by an average of 14-16%.

RARE MAMMALS

Five species were captured too infrequently to permit statistical analysis (1-6 individuals). Two yellow-footed antechinuses *Antechinus flavipes*, a swamp rat *Rattus lutreolus*, and a house mouse *Mus musculus* were captured at Barrine. Musky rat-kangaroos *Hypsiprimnodon moschatus* were captured at Eacham (1 animal) and Gadgarra (2 animals), and were occasionally observed during the day at all three sites. Finally, two long-nosed bandicoots *Perameles nasuta* were captured at each of the three sites.

DISCUSSION

Our short-term survey was unlikely to provide a complete census of small mammals in the study area.

Repeated sampling during the major seasons of the year, and the use of ground- and arboreal-traps with both meat and herbivore baits, are needed to provide a comprehensive sample of rainforest small mammal communities (Laurance, 1992). There also was a two-month interval between censuses of the parks and the controls. Results, therefore, should be interpreted with some caution.

ABUNDANT RODENTS

Despite limited sampling our findings appear similar in several respects to those observed in larger (20ha) forest fragments on the southern Atherton Tableland (Laurance, 1994b), suggesting the small mammal faunas at Lakes Eacham and Barrine exhibit some effects of forest fragmentation.

On average, assemblages of abundant native rodents were 14-16% more abundant in Eacham and Barrine than in nearby unfragmented forest, although this difference was not significant. On the southern Atherton Tableland (30-40km south of Eacham and Barrine), the same rodent species were on average 20-27% more abundant in fragments than continuous forest (Laurance, 1994b). These increases may result from ecological changes in fragmented rainforest, such as dense ground and understorey cover associated with forest edges and disturbed forest, that are favoured by some rodents. A recent comparison of forest structural variables at Eacham and Barrine with nearby continuous forest, suggested the parks exhibit relatively heavy disturbance, which may result from increased wind damage near forest edges compounded by the relatively high topographical position of the parks (Laurance, 1994a). Native rodents may also increase in fragments because of novel foraging opportunities in surrounding pastures or secondary habitats, or because larger, forest-dependent predators decline in most fragments (Laurance, 1990; 1994b).

The fawn-footed melomys *Melomys cervinipes* was significantly more abundant at Eacham and Barrine than in unfragmented forest. On the southern Tableland, this species also was more abundant in both small (1.4-12.7ha) and large (21-590ha) fragments than in unfragmented forest. *Melomys* appears to favour recent treefall gaps and other disturbed forest, which probably accounts for its success in remnants (Laurance, 1994b).

The bush rat *Rattus fuscipes* was much less abundant in the parks than continuous forest, while the Cape York rat *R. leucopus* was unusually abundant at Barrine but less abundant at Eacham and the controls. Cape York rats increased on the southern Tableland in many smaller (<20ha) forest remnants while bush rats generally declined. Like the fawn-footed melomys, the Cape York rat appears to favour forest edges and areas with many treefalls and

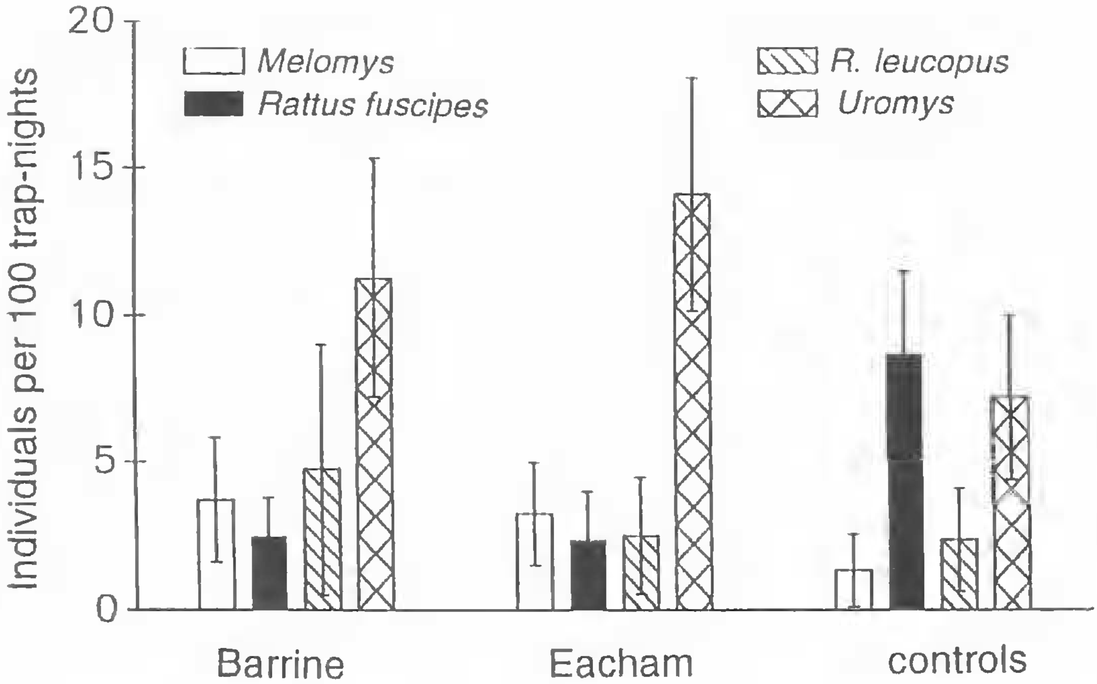

FIG. 2. Standardised abundance estimates (mean + σ) of four abundant rodent species from trapping transects in Lake Eacham and Lake Barrine National Parks, and in nearby continuous forest (Gadgarra State Forest).

dense rattan growth, while the bush rat generally avoids areas with high densities of Cape York rats (Laurance, 1994b).

The white-tailed rat *Uromys caudimaculatus*, a large (500-900g), aggressive omnivore, was unusually abundant in both parks. In a trapping survey in the 1970's, J. W. Winter (pers. comm.) also found the white-tailed rat to be the most frequently-captured small mammal at Lake Eacham. These results differ from observations on the southern Tableland, where white-tailed rat abundance did not differ significantly between larger (>20ha) fragments and continuous forest (Laurance, 1994b). Elevated abundances of white-tailed rats in fragments could result in intensified predation on large rainforest seeds (Osunkoya, 1993), nesting birds and small vertebrates (Laurance et al., 1993; Laurance & Grant, 1994). In future studies, it would be useful to contrast the intensity of predation in the parks with that in continuous forest, using seeds or experimental bird nests (e.g. Laurance et al., 1993; Harrington et al., in press).

RARE MAMMALS

Two non-rainforest rodents were captured at Lake Barrine, the house mouse *Mus musculus*, commonly associated with human habitations, and the swamp rat *Rattus lutreolus*, which usually favours open, grassy habitats. J. W. Winter (pers. comm.) captured *Mus musculus* and *Rattus rattus* at Lake Eacham in the 1970's, although we did not encounter these species at Eacham in 1994. Non-rainforest rodents also were encountered, albeit infrequently, in many forest fragments on the southern Atherton Tableland (Laurance, 1994b). Thus, forest fragments appear increasingly prone to invasions by non-native rodents although native rodents, which are abundant and highly territorial, probably prevent large-scale invasions of non-forest species.

Interestingly, Lake Barrine is the type locality for *Rattus lutreolus lacus*, a disjunct north Queensland subspecies initially encountered in 1937 (Taylor & Horner, 1973). In the 1970's J. W. Winter (pers. comm.) attempted to confirm the presence of *R. l. lacus* in the parks and intervening paddocks, but did not encounter it. Our study confirms the presence of swamp rats in the area. The single animal we encountered was captured inside Lake Barrine Park, 160m from the nearest forest edge.

The frequency of trapping of *Antechinus* varies considerably during the year, peaking from about March to June (Laurance, 1992), and the present study would have been unlikely to sample these species adequately. We captured only two yellow-footed antechinuses *Antechinus flavipes* at Barrine, and none at Eacham or in continuous forest. On the southern Tableland, *A. flavipes* strongly favoured forest fragments over continuous forest and usually was captured within 30 m of forest edges (Laurance 1994b). The Atherton (*A. godmani*; Laurance, 1993) and brown antechinuses (*A. stuartii adustus*), both of which are strongly rainforest-dependent (Laurance, 1994b), also could potentially occur at Eacham and Barrine. Ideally, both remnants should be thoroughly sampled during the optimal trapping period for antechinuses.

The rare spotted-tailed quoll *Dasyurus maculatus* was not detected during the study and is unlikely to persist in the parks. However, both parks currently maintain good populations of the musky rat-kangaroo *Hypsiprimnodon moschatus*, a rainforest endemic. This species appears to have disappeared from even the largest (up to 590ha) fragments on the southern Atherton Tableland (Laurance, 1994b), although it was detected in a few small fragments on the north-central Tableland that nearly abutted continuous forest (Grey, 1994). The musky rat-kangaroo is strongly rainforest-dependent, thus populations in the two parks may be genetically and demographically isolated from other such populations.

A recent initiative by the Queensland Department of Environment and Heritage to establish an 80m-wide faunal corridor between Lake Barrine and Gadgarra State Forest, may facilitate dispersal of musky rat-kangaroos and other forest-dependent species, reducing the isolation of faunal populations at Barrine. The effectiveness of such corridors has not yet been rigorously assessed (cf. Noss, 1987; Simberloff & Cox, 1987; Bennett, 1990), however, and future research is clearly needed to test the efficacy and design of faunal corridors, especially in the tropics.

ACKNOWLEDGEMENTS

We thank John Winter, Les Moore, Luke Leung and Peter Green for commenting on earlier drafts of the manuscript. Eleanor Collins, Arthur Sellers and others from the Lake Eacham National Park Volunteers Group assisted with field work. This project was partially supported by a senior research fellowship awarded to WFL by the Wet Tropics Management Authority.

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